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THE INTEGRAL ENERGY- ECOLOGICAL TRANSITION FOR THE CONTAINMENT OF EMISSIONS OF POLLUTANTS AND GREENHOUSE GASES

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Energy sources for the integral ecological transition

Integral ecological transition means a stage of human development where the use of energy and matter to the needs and production activities of mankind is made sustainable , that is in balance with respect to the planet's natural resources.

The transition in the energy sense is embodied in progressively replacing energy sources not eco- sustainable with sources eco- sustainable. The eco-sustainability takes into account the depletion of non-renewable primary resources and impact on the environment (for believers Creation) that can lead to reversible or irreversible damage conditions for the ' man and his habitat.

The parameters that must be kept under control for this purpose , and brought back to the desired values, are above all the emissions of greenhouse gases into the atmosphere, in particular CO_2 (carbon dioxide), due to the possible effects on the climate, and the pollutant emissions, in particular VOCs (volatile organic compounds), PMs (small solid particulates), nitrogen compounds (amines, furans), sulfur, responsible for acid rain. Not to be overlooked are the impact effects of civil and energy infrastructures on the territory, in particular the pollution of the soil and water, in addition to environmental degradation and the loss of agricultural and forestry resources .

Since the human Population is increasing, despite the stagnation in developed countries, and the need for energy per - capita as well, the overall demand for energy increases exponentially because of the combination of the two factors.

Furthermore, the use of the fossil source in all sectors, transport, civil, tertiary, electricity, is currently dominant, and the transition to a carbon-free world, that is, without fossil combustion and carbon burning, is a slow and difficult process.

A further problem is given by the level of CO_2 concentration that has been forming in recent decades, and that even if we decided today not to burn more fossil (but it is impossible), it would not return to the desired levels if not after very long times; so today's goal is to "contain" these emissions to the maximum, setting the target of not exceeding the "no return" concentrations for the climate and the human environment. This threshold can usefully be set to 500 ppm of CO_2 in the air, even if only as a "working hypothesis".

There is a further aspect to be clarified, with respect to energy sources and energy infrastructures , namely the life cycle of an engineering work. In fact, in the life cycle of an engineering work, the phases of material supply , energy production (operating life) and disposal must be considered. It should be that all the phases must be eco-friendly and not only the operational production. Indeed, sometimes, the initial and final queues of the life cycle, the so - called *front-end and back-end*, are unsustainable, even if the operation phase was totally *clean* . The sustainability report must therefore be comprehensive.

All this being said, then, how to achieve the integral ecological transition, how to respect the generational pact between those who have made the current technological revolution and the new generations who want *green*, *clean*, environment, but also used to using *native* technologies in the daily?

We must stress the importance of studying in the school world. In fact, only by studying can the tool be used to make informed judgments, beyond *slogans*. For example, a little knowledge of physics, chemistry, mathematics, and thermodynamics is fundamental to understand quantities such as energy, heat, efficiency and efficiency.

Just as scientific research is important in this field, as far as possible free from the influence of politics, finance and ideologisms.

Moreover, man's progress has never stopped, and will not stop, because it is innate with man to invent and innovate . Then, each human invention can be used badly or well, not for this it must no longer invent and progress (the example of the knife that can help but also hurt is a classic, from this point of view) .

Science has made human knowledge and technological inventions available to men, giving up a priori would be a sin as using it badly.

If God created us in this way and created the earth for us in this way, he certainly did it well and for good. As atoms, the nuclei, the molecules, the electrons, the protons, the radiation , the nuclear processes on the sun and the earth, are the stuff created and shaped by the Lord. So all must be used and well, for man's happiness and thanksgiving to God.

This premise is useful for understanding that then the ecological transition needs everything and everyone. It is also evident that the ecological transition necessarily passes through an energy transition.

In turn, each energy source must be evaluated for the advantages and disadvantages it presents and its specific life cycle . Let's then briefly examine the different sources starting from what we would like and should reduce and finally "eliminate", the fossil source.

Fossil fuel and natural gas

Among the fossil sources (*high carbon*) , which today make up about 80 % of the planet's primary sources (coal, fuel oil and derivatives, natural gas - methane, etc.), the best for the energy-ecological transition is certainly natural gas, the worst coal, fuel oil in the middle. For some applications, those of transport, the fossil source will go on for decades, it is useless to have illusions. Natural gas burning obviously generates CO_2 ($CH_n + O_2 = CO_2 + ½ nH_2$) , but not particulate matter (PM) . In the ecological transition, therefore, the natural gas will be able to play a key role, but will increase the CO_2 , and therefore also is intended to be replaced, in particular to "hydrogenate" more and more, that is to be mixed and gradually replaced from hydrogen (see below) .

One of the natural gas problems is coming largely from oil producing Countries, or from Russia, through pipelines long thousands of kilometers (*hub)* , or in liquid form ch and then requires plants to re-gasification, not always well accepted by some populations . For some years, starting from the United States, the new extraction technique from bituminous *shales* (*shale-gas*) has spread , which in fact has made the United States energy independent and potential major exporters of gas and oil (and it also has them allowed to replace many coal-fired power plants with gas-fired ones, drastically reducing harmful emissions). The the fossil fuel being so important and possessed by few countries, feeds easily wars and conflicts , declared and hidden around the world.

Biomass energy, that is the "old" firewood, which man has burned since the discovery of fire, is also a *high-carbo n* and highly polluting source for particulates and toxic compounds. S and usat in large quantities, would contribute significantly to the increase in CO_2, air pollution, and to deforestation. In fact, one thing is a fireplace in the home and it is different to feed an industry with the combustion heat of biomass; for local and domestic uses traditional, if it occurs in high-quality apparatuses, the combustion of the biomass remains still acceptable and does not affect significantly on the energy-environmental balance general.

We now come to the main *carbon* free sources , those to be pursued and incentivized, which are : hydroelectric, nuclear, wind, solar , geothermal , and a carrier, hydrogen.

Hydroelectric power

Hydroelectric power consists of converting gravitational energy and the thrust of water into electrical energy through systems equipped with a hydraulic turbine, located on large rivers also in the plains, or downstream of forced pipes fed by mountain basins . Apart from the impact on the territory, which however can be correctly managed in normal operation , this energy has in the past caused catastrophes with thousands of victims due to the collapse of the dams. The contribution of this source, however, is strictly conditioned by the conformation of the territory of each country: it ranges from 100% of Norway, to 50% of Sweden, to 20% of Italy, to an almost zero contribution in the flat countries.

Solar power

Photovoltaic solar energy (PV) , despite having heavy needs for even special and toxic raw materials (including " rare earth ", now practically a monopoly of China) in the front-end and disposal in the back-end (PV panels) , in the production phase it is totally *carbon free* . However, its most serious limitation is that energy production is not programmable by man, and shows a variable trend over the day and year . Therefore it is used as f onte integrative other programmable sources and not to load the base , with a percentage contribution of the mix that does not exceed greatly her " factor capacity" (ie the ratio between the energy actually produced in a year and what would have been produced if the system could always have operated at its rated power). The "load factor" of photovoltaics, for a country in the middle latitudes like Italy, is around ,10 -15 %.

The goes rehabilitates could be possibly compensated with *capacity storage* , i.e. storage systems , but installing then panels for a nominal power in the year such as to provide all the energy required by the network (in fact, it is necessary to install panels to a much greater nominal power of the maximum power required by the electricity grid): the investment costs in infrastructures, in particular for seasonal storage systems at medium latitudes, become practically unsustainable. In addition , the very low energy density at the origin of photovoltaics, as well as thermodynamic solar powered by mirrors, implies a very vast occupation of the territory to obtain significant powers and, with the commitment, extensive areas that take away space from agriculture and leave the land in degradation conditions. For home use, you can suggest the king instead the installation of civilian facilities under construction , following specific integration criteria in the structures.

Wind power

Wind energy is an energy to be exploited especially on the sea, *off-shore* , or in areas with strong and constant winds, factors that in Italy are quite scarce, but abound in northern Europe for example. Even this source is of low intensity , even less than solar, if we refer to the wind farm in its total extension, and not easily programmable, even if in suitable areas it certainly presents greater constancy of production.

Attention also for this source to the life cycle queues , and above all to the energy costs of construction , which sometimes exceed the energy produced by the wind turbines during their entire operating life , not exceeding 15 or 20 years.

Geothermy

Geothermal energy is a natural energy already available, to be extracted from the depths of the earth at about 100-200 m, through water as a vector fluid that vaporizes and drags a steam turbine . Where this possibility exists, eg Iceland, geothermal energy is a free and inexhaustible source. Obviously, at times the availability of geothermal energy is far too much and not controllable , as in volcanic eruptions , which indeed are a formidable emission source of CO_2 , as well as a danger to populations.

Nuclear Power

Nuclear energy can come from the fission of a heavy atomic nucleus or from the fusion of light atomic nuclei .

The first is already operational in the world (since the 1960s) with more than 400 nuclear reactors in operation and produces 10 % of the world's electricity (which represents the main use of civilian nuclear power). The new generations of reactors guarantee high safety features that have treasured the few but important accidents that have occurred in the history of this technology. The production of nuclear energy is totally carbon-free and countries like Sweden and France, and in general Europe, the USA, and Asian countries make extensive use of it. The costs of nuclear energy are mainly linked to the investment for the construction of the plant, while the operation has very little impact , for an operating life that now reaches 60-80 years . At the moment of the dismantling of the plant, the radioactive waste that is generated during life is placed in long-life geological surface or underground deposits . Long-term sustainability is ensured by the closed cycle of the fuel with fast neutron reactors , which allow to recycle long-lived radioactive waste by burning it producing more energy, and transforming it into medium-short life waste. The energy density is very high, and therefore the impact on the territory is minimal for the same generated power. Production is programmable and usually constant with high load factors,

Fusion energy is still a research topic, the timing and feasibility of which is not known.

<u>Hydrogen</u>

The hydrogen carrier, as mentioned, will have the role of replacing natural gas, from which it can be obtained with the *steam-reforming process* , which however produces a lot of CO_2 . For a massive production of *carbon-free* hydrogen, it is necessary to think of electrolysis with *carbon-free* electricity *,* that is, from a renewable or nuclear source. Since electrolysis plants are very expensive, and therefore it is convenient that they are used with the utmost continuity, from the economic point of view, the most convenient option appears to be nuclear. By placing then in the future nuclear reactor at high temperature, you can also use the way of dissociation thermochemical water , high temperature obtainable with processes endo- energy. Hydrogen should then be channeled as it is done with natural gas with natural gas pipelines and gas networks , but the current structures do not seem suitable to resist the corrosion of high concentrations of hydrogen: here too it would be a matter of rebuilding huge new infrastructures . The hydrogen *carbon-free* thus produced can then be used in transport means equipped with electric motor, in which case it can produce electricity by electrochemical through a fuel cell.

Power from waste

Waste energy has a dual objective: to help solve the problem of urban and industrial waste disposal and to exploit the energy and material potential still present in waste, aiming on the one hand to achieve the circular economy (recycling, reuse, recovery) and on the other to avoid burning fossils for urban heating or industrial heat. So even if CO_2 is produced, that from fossil fuel is avoided.

Summarizing, with this package of energy sources it is possible to face the integral ecological transition, of progressive replacement of *high-carbon* sources , to limit the production of CO_2 and the emission of pollutants from fossil energy.

How to modulate the sources?

To reduce CO2 emissions more and more and keep electricity supply reliable, in an increasingly electrified world in the end uses of heating, transportation, industry , we can think of following the French and Swedish model, which provides for an intelligent and optimal mix , in which the non-programmable sources (FER) compete for the variable part of the production, up to 50%, so if the FER (and storage system) increase, fossil sources, possibly only gas natural, it is reduced. The remaining part of the mix is supported by nuclear and hydroelectric / geothermal which make the base load for a minimum of 50%. In this way, the production of CO2 is given only by the residual component of natural gas, which would slowly drop to 0 together with its expected transition to hydrogen.

Transition integrated ecological and conversion of nuclear weapons for civil use

The two crucial issues of the integral ecological transition and conversion of atomic warheads in peace fuel, can be tied together by the calculation of how much nuclear fuel (carbon-free) to 3-4% of U235 is done with a warhead (plutonium and / o 95% uranium) and how much CO2 emission is avoided by generating electricity (MWe) with this quantity of fuel.

At the end of the calculation an estimate of the quantity of CO2 (ton) / dismantled atomic warhead will be obtained.

If we consider the 15,000 atomic warheads still present, the calculation provides the total tons of CO2 avoided with their conversion.

15,000 warheads feed approximately one hundred 1000 MWe nuclear reactors.

Each reactor produces a thermal power of approximately 3000 MWt and therefore an annual energy of 8760 h / year x 3600 sec / h x 0.8 (80% of the load factor).) = 75.686 MWht / reactor .

If we multiply by 100 reactors we get 7,568,000 MWht / year .

One 1000 MWe reactor saves per year, while compared to an equivalent thermal power plant about:

300 kgCO2 / MWht x 7.568.000 MWht / year = 2.270.000 Ton CO_2 per year.

For medium-efficiency heating systems, this saved quantity can also double. A value of 3,000,000 tons is more than realistic.

If we therefore evaluate that the duration of a charge of nuclear fuel (about 100 tons) can make the reactor work for 4-5 years (two-three refills of fuel), we can obtain an overall avoided CO2 emission of 15,000,000 tons. CO2

We can therefore conclude in an approximate but realistic way that converting 15,000 atomic warheads allows, in addition to eliminating the danger of an atomic war, to produce 100,000 Mwe of electricity for civil use and save 15,000,000 tons of CO2 in the atmosphere, i.e. 1000 tons with converted head.

If we then add the 100 reactors to the existing 400, we arrive at a avoided CO_2 equal to

15 MTon x 5 = 75 M ton / stone (about 5 years)

Obviously it is a good contribution of CO_2 avoided by an electric source, but certainly small compared to about 25 Gt on total emitted every year from a fossil source. For more detailed calculation See Bibliography [1]

But of very high symbolic value because we have eliminated a threat of nuclear war, we have produced electrical energy of peace for civil use, and we have avoided the emission of CO_2 into the atmosphere.

Energy for Humanity - What prospects for the future?

The evolution of Humanity, starting from the distant prehistory, is strictly conditioned by the availability of abundant and easy-to-use energy sources. The demographic explosion of the last century is a consequence of the systematic exploitation of fossil sources, however limited and in any case producing huge quantities of greenhouse gases, and in particular of carbon dioxide (CO_2).

With the end of the last ice age, about 11,000 years ago, and probably thanks to the consequent stabilization of the climate,*Homo sapiens* was able to adopt the techniques of agriculture and breeding on a large scale, and therefore to build permanent centers. ever larger (period of the Neolithic civilizations). However, the population growth rate never had to exceed 0.1% per year.

Neolithic civilizations led to the most profound transformation of the natural environment that has occurred so far: extinction of many animal species, in particular the megafauna of the ice age; destruction of vast expanses of forests to make pastures and fields; consequent release of large quantities of CO_2 and methane, which could have influenced the climate to the point of having so far delayed the "natural" trend towards a new ice age. In this way, the human population was able to reach hundreds of millions of individuals in historical times.

But only the development of modern science from the seventeenth century in Europe, and the consequent technological and industrial revolution, have given rise to a demographic explosion that in three centuries has brought the world population to over seven billion individuals (the rate of increase, now down, had reached a maximum of 2% per year, that is, a doubling in 35 years!). This is a trend that, for other living species, normally leads to a catastrophe ...

The countries that generated and managed the scientific and industrial revolution have now led to a stable (or decreasing ...) population regime with high living standards. But that same revolution has extended new health and pharmacological techniques to the whole world, which have reduced infant mortality and extended the average life even in pre-industrial countries.

Except for health or planetary catastrophes , or huge migratory flows, the forecasts of the demographers are as follows:

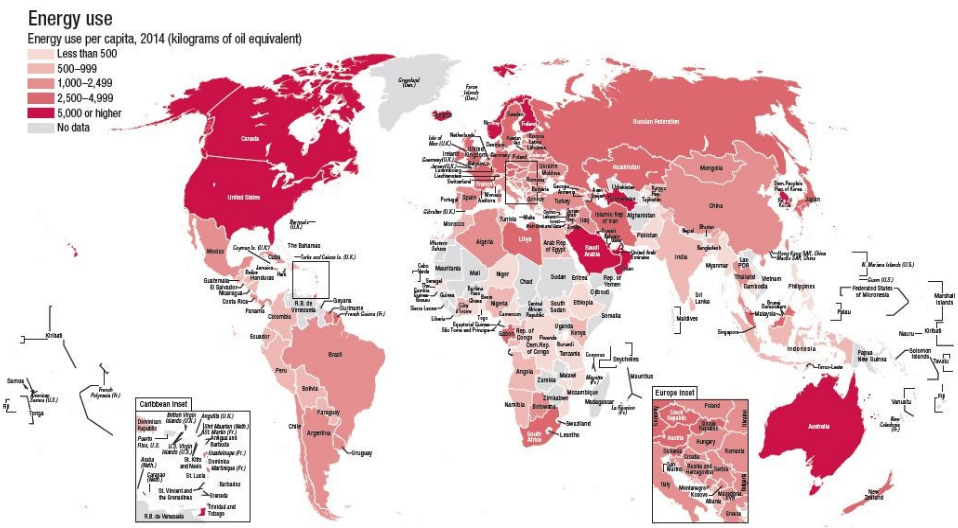
TABLE 1. POPULATION OF THE WORLD AND MAJOR AREAS, 2015, 2030, 2050 AND 2100, ACCORDING TO THE MEDIUM-VARIANT PROJECTION

Major area	*Population (millions)*			
	2015	*2030*	*2050*	*2100*
World	7 349	8 501	9 725	11 213
Africa	1 186	1 679	2 478	4 387
Asia	4 393	4 923	5 267	4 889
Europe	738	734	707	646
Latin America and the Caribbean	634	721	784	721
Northern America	358	396	433	500
Oceania	39	47	57	71

Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*. New York: United Nations.

As is clearly seen from the table, g imbalances them in developing economic and demographic have already leads to , and will lead always more, to strongly overpopulated areas with respect to the resources generated therein , particularly in Africa . Instead, thanks to the systematic exploitation of natural heritages, in particular of highly concentrated fossil energy reserves (coal, oil, methane), today about a seventh of the world population has achieved a standard of living (and energy consumption) never seen in the history, and even an order of magnitude higher than the rest of Humanity, as is evident from the following map.

SLIDE



From : **https://data.worldbank.org/products/wdi-maps**

Until the end of the 20th century, a clear distinction was made between "developed industrial" countries , essentially those belonging to the Organization for Economic Cooperation and Development (OECD, OECD in English), and other countries, defined as "underdeveloped", or "developing" . In fact, in the last two decades, unexpectedly, almost half of humanity has undergone a high rate of development: it is, as is known, China, India, Brazil, South-Africa and all of South East Asia.

Some environmentalists and political scientists suggest tackling this emergency with a drastic control of demographic development (obviously not in developed countries with a stable or decreasing population, but in developing ones). But such a policy appears even more difficult to make the countries concerned accept than the plans to reduce greenhouse gas emissions, and in any case it would only have long-term effects (i.e. well beyond the middle of this century, which is considered the critical date for climate stability).

Certain "nostalgic" attitudes, frequent in our rich and spoiled countries , exalt the "economic decrease" and the " return to nature " , but they are out of place. In fact, even if the rich countries disappear overnight, and the resources they consume were destined for other countries, they would slightly improve their standard of living, remaining well below their expectations.

The "return to nature" to safeguard the planet, then, should certainly not be limited to returning to before the industrial revolution, when the agricultural revolution had already profoundly changed the "natural" environment, but it should refer to the Paleolithic or even earlier, when the planet could only support a few million individuals: what then to do with the rest of the current population?

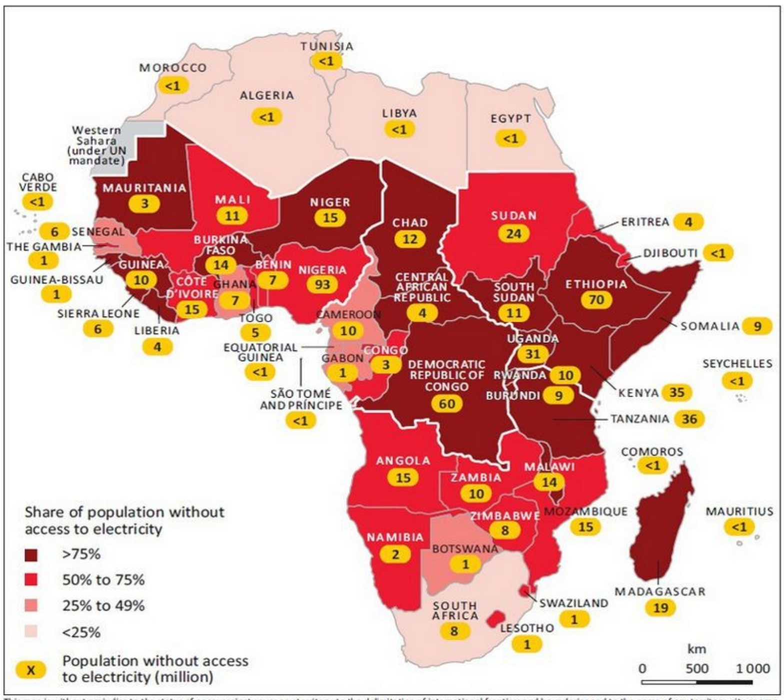
In this regard, the 1987 Brundtland Report was commissioned by the United Nations to outline a globally sustainable future. It was written by environmentalists and sociologists (obviously born and raised in the cotton wool of the richest countries in the world), who believed they were entitled to say that, in order to safeguard the planet, poor countries should not have repeated the development path followed from rich countries, but they should have pursued a path of low energy intensity, based on generation spread from renewable sources.

In reality, things are going very differently: the large underdeveloped countries, some of noble and very ancient cultural tradition, assimilated the technologies and the financial and organizational capacities necessary for industrialization, are starting on an even faster pace of development than that of the old industrial countries, even aiming for world leadership in many sectors, and in particular in the energy sector. The availability of cheap and possibly clean energy is the basis of this development.

However, in these countries a large part of the new power plants are coal-fired. As a result, hundreds of new plants are under construction or planned in the world over the next 10 years (which presumably will remain in operation for 40 or 50 years!). A large part will be built by the Chinese industry, both for China itself and for export, so as to keep the rate of use of the enormous production capacity developed in recent decades to industrialize the country high.

Then we have India, which must triple its installed electrical power, largely with fossil fuels. Then we have Indonesia, Vietnam, the Philippines, etc., and also Japan, which after the Fukushima event had to permanently shut down the older nuclear power plants.

Then we have Africa, which is "hungry" for energy, and where China has been investing for years with the aim of making it the future "manufacturing of the world" (while you would move on to the post-manufacturing economy ...): also in Africa , China builds a hundred coal plants. On the other hand, Africa, as seen from the previous Table 1, is the continent that will double its population in the next thirty years, and, as seen from the following map, it includes the countries with the largest fraction of the population without electricity.



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

SLIDE

From: https://www.thegwpf.com/african-nations-plan-more-than-100-new-coal-power-plants/

The challenge that now arises is then to better manage the difficult transition to a U Manita at the end of the century could reach 10 to 12 billion for individuals, each of whom can not be denied the right to a standard of living , and therefore to energy consumption, comparable to those of the current developed countries (not necessarily those of the citizen of the USA, but those of the average Italian of today, for example).

The case of Africa

To give an updated picture of what is happening in Africa, we refer to the Inquiry " The dream of Africa risks dying in its big cities ", by Paolo M. Alfieri, sent to Dakar , published by "Avvenire" of Sunday 1 March 2020 :

<Africa is the region of the world where the rate of urbanization grows faster but also the one where the phenomenon, intersecting with other factors, risks being potentially more risky. The continent of villages and small cities is increasingly disappearing, giving way to a territory in which the suburbs widen and the slums multiply, without the infrastructure - from waste management, to roads to basic services for citizens , like schools and hospitals - manage to hold up. From the 1990s to today, the urban population in sub-Saharan Africa has more than doubled, so much so that over 40 percent of Africans now live in cities, compared to 31 percent two decades ago, a figure that could reach 75 percent by 2050. Not only that: 65 percent of residents live in slums, where precarious sewage systems present public health problems.>

and again:

<The experience of these years, some analysts pointed out, shows that urbanization cannot be reversed, given that too few people are willing to return to rural areas after a few years in the city. This is why, at least, managing the phenomenon better is the only way to avoid being affected by it, also considering that the consequences of climate change will, if anything, contribute to exacerbating it. Cities are increasingly exposed to both water scarcity (the example of Cape Town in South Africa remains emblematic) and, on the other hand, to sudden floods, not to mention, for coastal centers, the impact of the rise sea level. >

These are "epochal transitions" well known to our old developed countries, starting from what happened in 18th century England, then in Central Europe in the 19th, ending in southern and eastern Europe in the 20th century (in Italy again after the Second World War). It will therefore be a great responsibility of our countries to take any useful action to support the African transition in the most rational and constructive way possible, on the one hand for obvious ethical and humanitarian reasons, but on the other hand also for our own "geopolitical" convenience of avoid an unsustainable migratory pressure from a neighboring continent of ours, which in thirty years will have a population four times Europe.

Regarding in particular the enormous investments announced by our countries to cope with the "climate change" (v. To e s . The proposal for the European Green Deal), keep pres en te that European countries have already achieved a reduction exemplary of the emission of climate-changing gases compared to the wealth produced (except Germany for known ideological reasons, and Poland which for historical reasons strongly depends on its coal). Q uindi to the known law of "diminishing returns", would be much more effective, in order to reduce future emissions worldwide , investing instead available resources in a proper energy transition in P AESI developing, such as those in Africa previously mentioned.

<u>The consequences on ecosystems SLIDE</u>

During the twentieth century, the world population has quadrupled and its energy consumption has multiplied by 16. Most of this energy comes from the burning of fossil fuels, with the consequent release into the atmosphere of a growing flow of carbon dioxide (CO_2). From the pre-industrial era to 2020 the concentration of carbon dioxide in the atmosphere has gone from around 275 to 410 parts per million (ppm), and continues to grow at the rate of 2 or 3 ppm / year. If we also take into account the other greenhouse gases, such as methane and nitrogen oxide, and aerosols, and their effect in CO_2 is reported , the total concentration now reaches 500 ppm of CO_2eq.

The dynamic correlations between the main climatological variables are essentially of the integral type, i.e. the downstream variable is the integral of the upstream one, except for the presence of stabilizing feedbacks with more or less long time constants . Based on these correlations, for an instantaneous introduction (or subtraction) of CO_2 into the atmosphere, 92% is still present (or removed) after one year, 64% after 10 years, 34% after 100 years, and 19% after 1000 years.

It therefore appears evident that the to-greenhouse effect has already "taken off" with a trend that is related to the "integral" of the increase in greenhouse gas concentrations that has already taken place compared to pre-industrial times. This increase is already very remarkable (for carbon dioxide , from about 275 to 410 ppm: about 5 0%), and will however persist to a large extent for many centuries. This increase will continue to cause an increase in the temperature of the atmosphere not only until it is blocked, but until it is completely eliminated with the return to pre-industrial concentrations. Currently, anthropogenic greenhouse gas emissions are equivalent to 37 billion tons per year for CO_2 alone , while total anthropogenic greenhouse gas emissions since the start of industrialization can be estimated in the order of 2 000 billion tons of CO_2eq .

Without active interventions on climatic variables , the return to pre-industrial concentrations through the "natural" carbon cycle would not be possible even after a millennium. However, if, through active interventions, we returned to pre-industrial concentrations, at that point the atmosphere and especially the oceans would remain to be cooled (the latter event much more arduous and slow, given their enormous heat content).

Not wanting to hypothesize global catastrophes, nor believing that authoritarian decisions can drastically reduce the economic and social level reached by many countries for decades, and prevent less developed ones from gaining access to an acceptable standard of living , it seems inevitable to believe that for many decades fossil fuels will still be predominant in energy production. Consequently, the concentrations of greenhouse gases in the atmosphere will continue to grow, and then it will be indispensable and urgent to systematically improve our knowledge of the dynamics of the climate, and begin to seriously consider the opportunity to proceed to the study and testing of all the means capable of directly contrasting the effects of Man on that dynamic.

If in the future it will be considered essential to limit the temperature rise to 2100 to no more than 2 ° C compared to pre-industrial times, in order to avoid unacceptable risks for the terrestrial ecosystem, as was also stated in the UN conference on climate held in Paris in 2015 (COP21) , then even the simple previous reasonings confirm the inevitability of "active" interventions on the climate. Moreover, COP21 itself made a clear assignment on the possible adoption, in the second half of this century, of techniques for removing greenhouse gases from the atmosphere, in order to compensate for anthropogenic emissions , which apparently are not supposed to be completely eliminated.

In a similar perspective, the most advanced countries from a scientific and technological point of view should assign a high priority to the study and testing of all means capable of dealing with the causes, as well as the consequences, of global warming. These issues can be considered the subject of a new discipline called

Geoengineering (a chapter of which is Climate Engineering): in essence, it is a question of considering the "terrestrial globe", constituting the Planet Earth, as an "environment" to be "air-conditioned" with the most advanced and efficient thermo-fluid-dynamic engineering technologies.

The techniques for the interventions of this type could then constitute the "last resort" to guarantee a long-term future for the current Human race , if the Holocene ends in a new Ice Age in times of hundreds or a few thousand years. This eventuality, in fact, appears practically certain from the history of the climate of the last million years, better known thanks to the cores of Arctic and Antarctic ice: it is in fact characterized by a long sequence of ice ages , which for long periods made almost the entire northern hemisphere uninhabitable.

What to do for Africa?

Given the worrying scenario of the "wild" urbanization in progress in Africa, as described above, the most urgent intervention appears to favor the formation of a large energy infrastructure, including interstate, based on hydroelectric plants (where possible), then on gas rather than coal, and later also on nuclear power plants. It will be said: what about renewables?

As we saw earlier, it is expected that three-quarters of the two and a half billion Africans planned to 2050 (from just thirty years: a generation!) Will live in cities: it is almost two billion people, which could be " settle "in 200 cities with 10 million inhabitants (but it is also expected that, for example, Nigeria will have more inhabitants than the United States, and that its capital, Lagos, will be the largest metropolis in the world ...).

These considerations may seem unrealistic in our old countries, which are considered "politically Correctly i " , and are slaves of unrealistic ideologies that preach a "return to nature" (which one? That of 1000, or 10 , 000, or a million Years ago?).

Conclusions

We generally know that today every year we increase the concentration of CO_2 in the atmosphere by about 2 ppm , that 1 ppm of CO_2 corresponds to the maximum 7.82 $GtCO_2$.

This quantity has led to an excess of CO_2 which has already begun to devastate our planet.

Therefore it is necessary as soon as possible to stop the emissions of other CO_2 in all possible ways and places in order not to reach the expected devastating 500ppm (almost double the natural value) of CO_2 in the air we breathe. This can be done by replacing the combustion of fossils (materials that are very useful for irreplaceable uses even for future humanity) the use of sources without GHG emissions, such as hydraulic energy, other renewable carbon-free products and energy nuclear. Furthermore, these plants can produce hydrogen which can effectively fuel transport of almost any kind and thus almost eliminate zero greenhouse gas emissions in the air.

It has also been noted that the major role of the introduction of new CO_2 will grow from the development of emerging countries. Therefore, it will be necessary for the more developed countries to drastically favor a development with carbon free energies, for example by allocating at least 10% of the European Environment Fund, just allocated by the EU for the next 10 years, which will serve to favor the priority development of the Villages and Agriculture in developing countries and to start using other carbon free sources that developed countries already use.

The energy transition that could take place according to the scheme outlined above with the determination to cancel all fossil combustion as soon as possible to all nations and reach the elimination of new emissions.

Thus CO_2 would not grow even more but would remain at these values with the consequent climatic and environmental excesses forever on humanity, if we do not intervene to reduce it first of all by promoting new forestation and reforestation in all areas of the planet.

In fact, we also know that a forest area in the tropical area of 1.7 MlKmq can absorb 7.14 $GtCO_2$ / year on average, ie almost how much CO_2 corresponds to 1 ppm in the air.

We therefore propose to reforest such a surface (which is equivalent to the burned or destroyed part of the tropical forests in the last 50 years) with ecosystemic care and to reconstitute a forest formation in moderate areas equivalent to this CO_2 absorption of tropical forests . We would thus begin to implement the reduction of 2 ppm of CO_2 / year.

So since the new anthropogenic emissions are zeroed, following the best intentions of countries in the world, we will reduce the concentration of CO_2 in the air by 40 ppm in the following 20 years. For example, if we zeroed CO_2 emissions to date, with these new forests, both tropical and in moderate areas, we would return to the values of 2000 in 20 years.

If unfortunately in the next few years the emissions continue at the current levels, with a consequent increase of 2ppm per year in the concentration of CO_2, the aforesaid reforestation, once fully operational, could perhaps just compensate for that increase.

Bibliographical references

[1] Program Conversion of nuclear weapons into development projects in poor countries
Presented at the Symposium of Assisi Sacro Convento - 11 November 2011
Study Day on Nuclear Disarmament, Non-proliferation, and Development
February 10, 2010 Casina Pius IV, Vatican City